

The Canary in the Coal Mine: A Cautionary Tale of Ocean Acidification and Shellfish

Bill Dewey
Taylor Shellfish Farms
Shelton, Washington



A warning from the sea

Oyster 'seeds' are dying as Pacific Coast waters grow warmer.

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ALSO



By Kenneth R. Weiss
Los Angeles Times Staff Writer
July 13, 2008

QUILCENE, WASH.— For decades, the unwritten motto at shellfish hatcheries in the Pacific Northwest was "Better oysters through science."

- Initial seed failures attributed to naturally occurring bacteria, *Vibrio tubiashi*

July 13, 2008
Kenneth Weiss

Is the Pacific
Ocean's chemistry
killing sea life?

Craig Welch
Seattle Times
6/14/2009



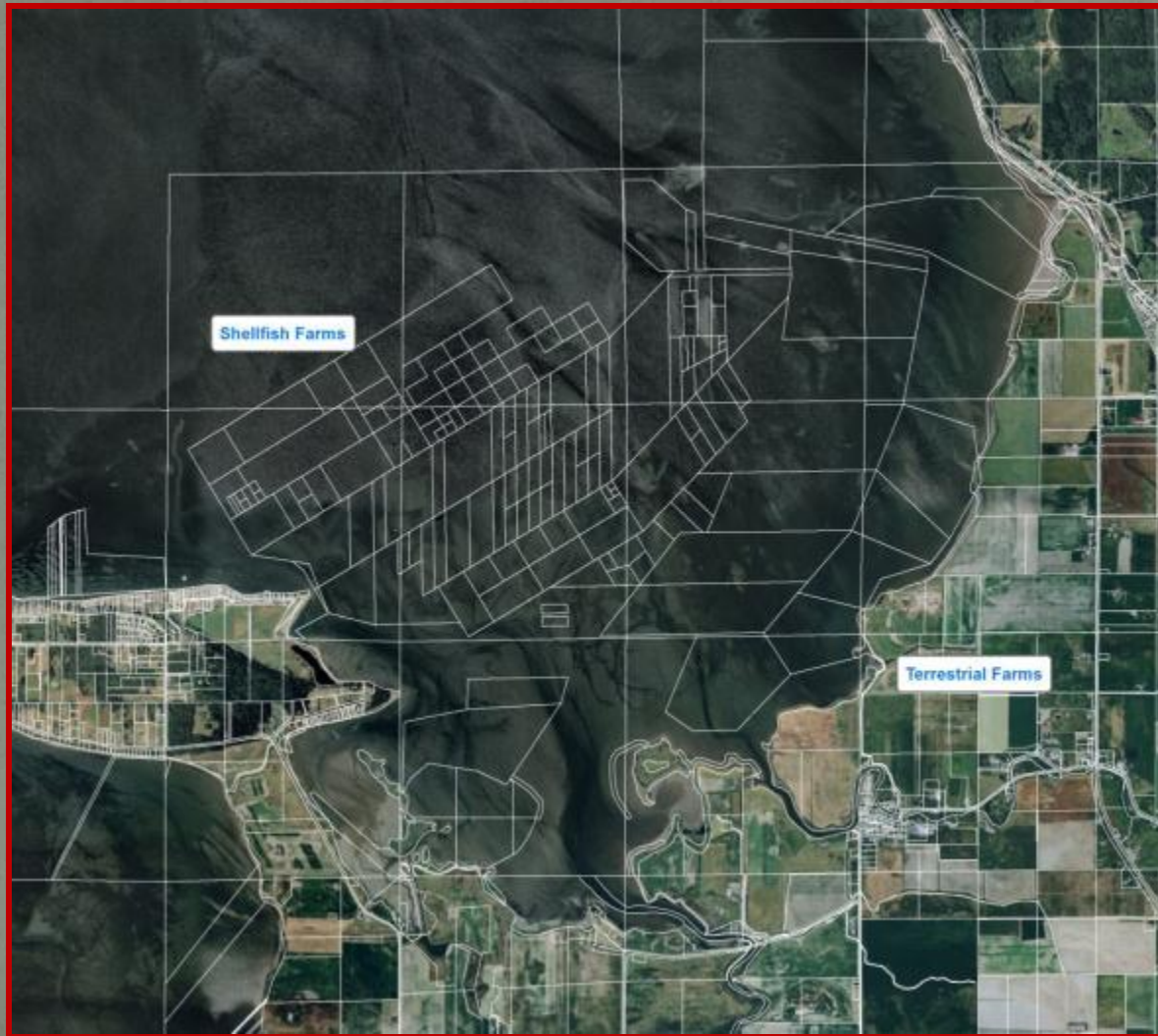
Economic value west coast farmed shellfish production

STATE	OYSTERS	CLAMS	MUSSELS	GEODUCKS	TOTAL
Washington	27,669 M/T \$57.75 million	4,309 M/T \$19.55 million	1,247 M/T \$3.16 million	748 M/T \$20.1 million	33,974 M/T \$100.56 million
California	4,205 M/T \$12.36 million	34 M/T \$0.83 million	46 M/T \$0.95 million	No record	4,684 M/T \$14.14 million
Oregon	1,080 M/T \$2.25 million	No record	No record	No record	1,080 M/T \$2.25 million
Alaska	94 M/T \$0.44 million	3.6 M/T \$24,841	0.9 M/T \$6,610	No record	98 M/T \$473,232
Total	33,048 M/T \$72,806,242	4,658 M/T \$20,404,841	1,391 M/T \$4,114,110	748 M/T \$20,100,000	39,845 M/T \$117,425,193

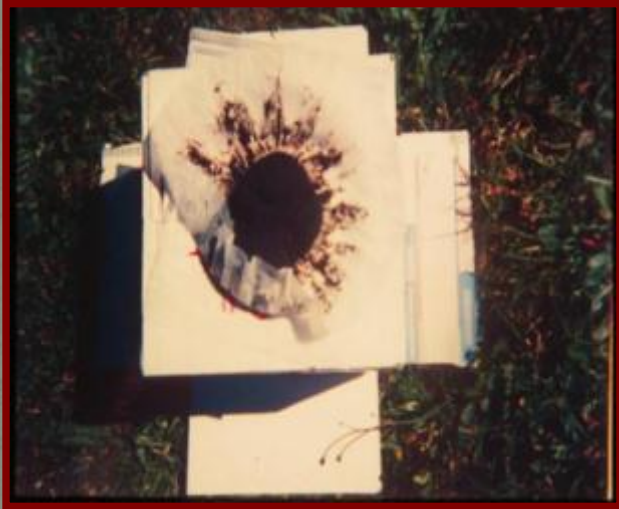
	OYSTERS	CLAMS	MUSSELS	GEODUCKS
% of shellfish	83	11.7	3.5	1.8
% of sales (\$)	62	17.4	3.5	17.1

- An estimated 3,000 jobs are provided directly or indirectly by shellfish culture
- Total economic impact for oysters with services, suppliers etc ~\$207 million

Samish Bay Bush Act tidelands



Oyster seed for cluster production



Pacific oyster clusters



Pacific oyster longlines



Harvesting Pacific oyster clusters



Harvesting Pacific oyster clusters



Manila (steamer) clams



Rows of Manila clams



Geoduck clams



Baby geoduck clams



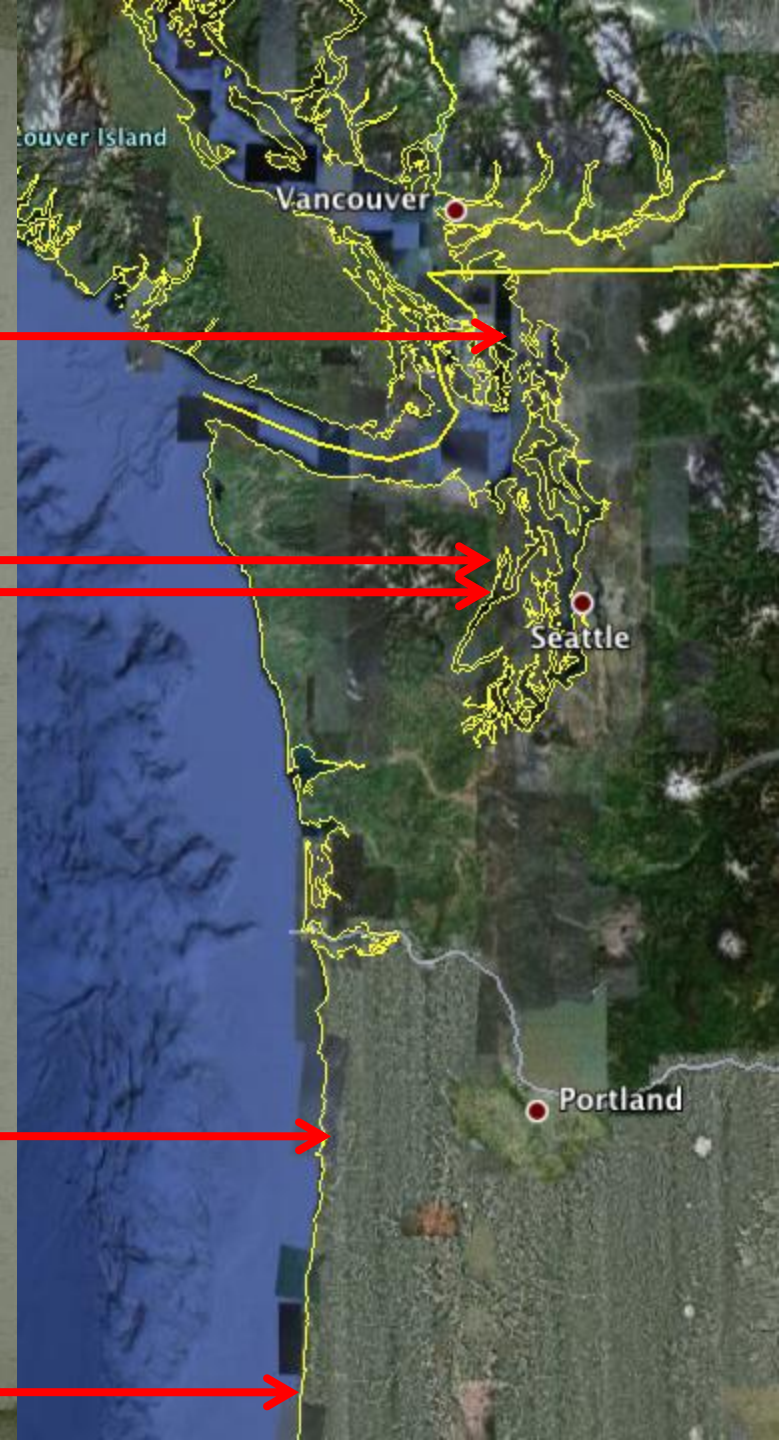
West Coast hatcheries

Lummi Hatchery

Taylor Hatchery
Coast Hatchery

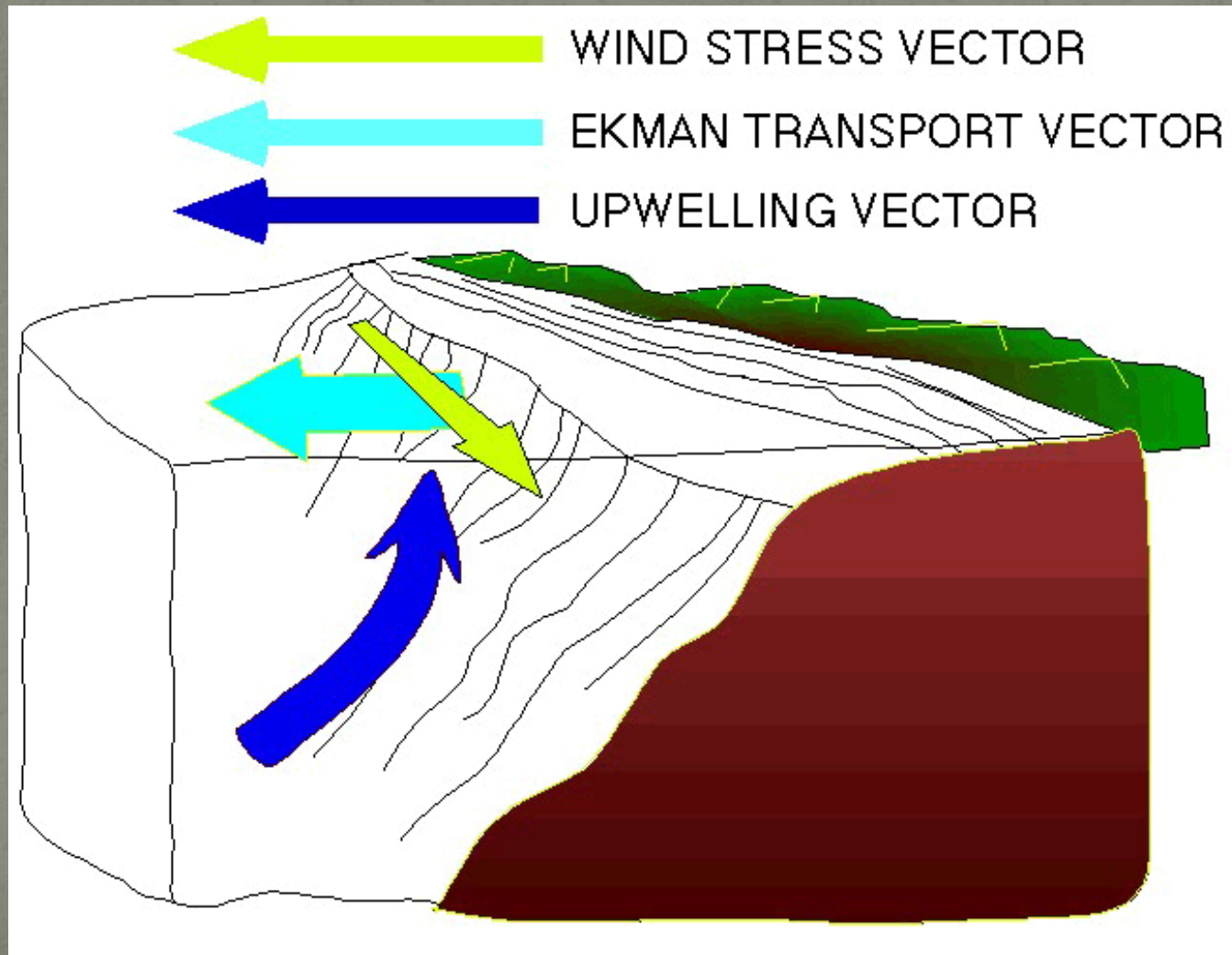
Whiskey Creek
Hatchery

MBP Hatfield Center

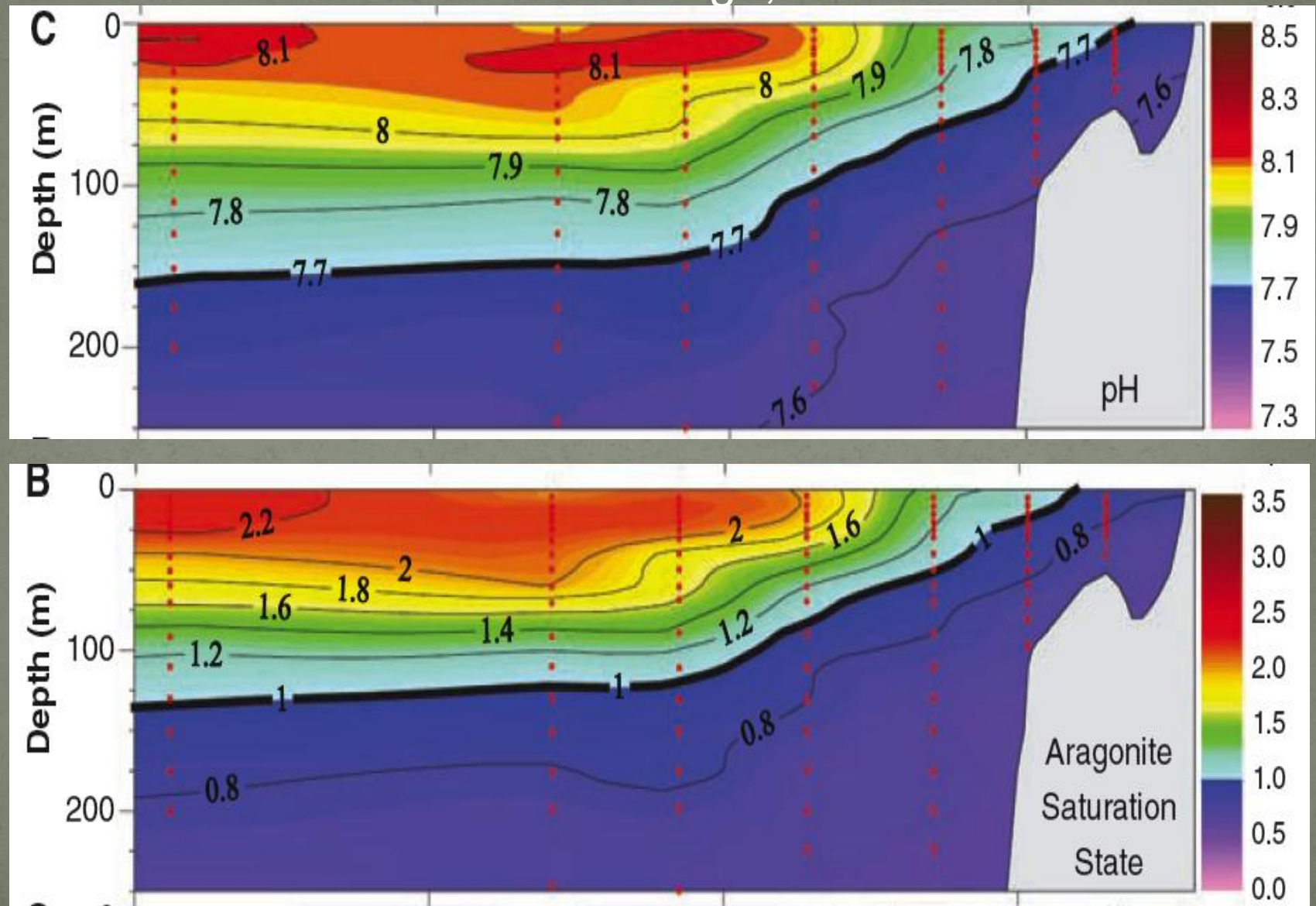


Upwelling on the West Coast

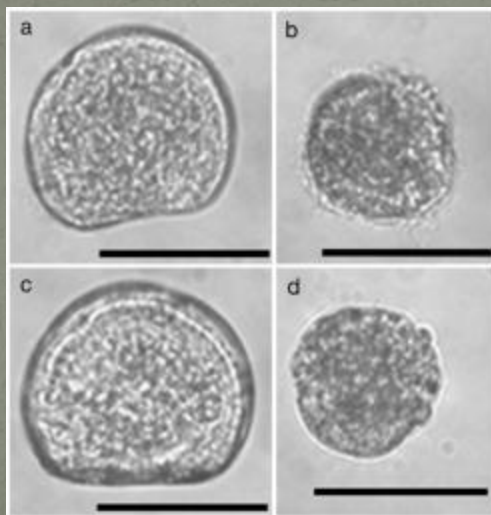
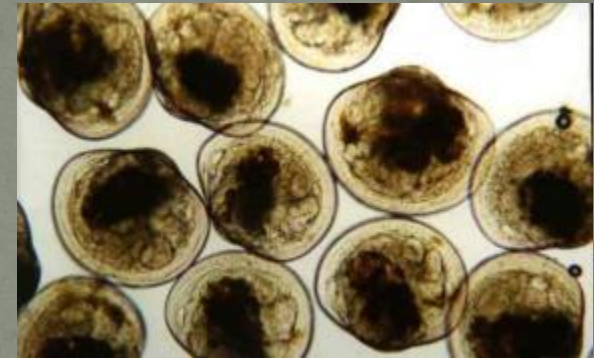
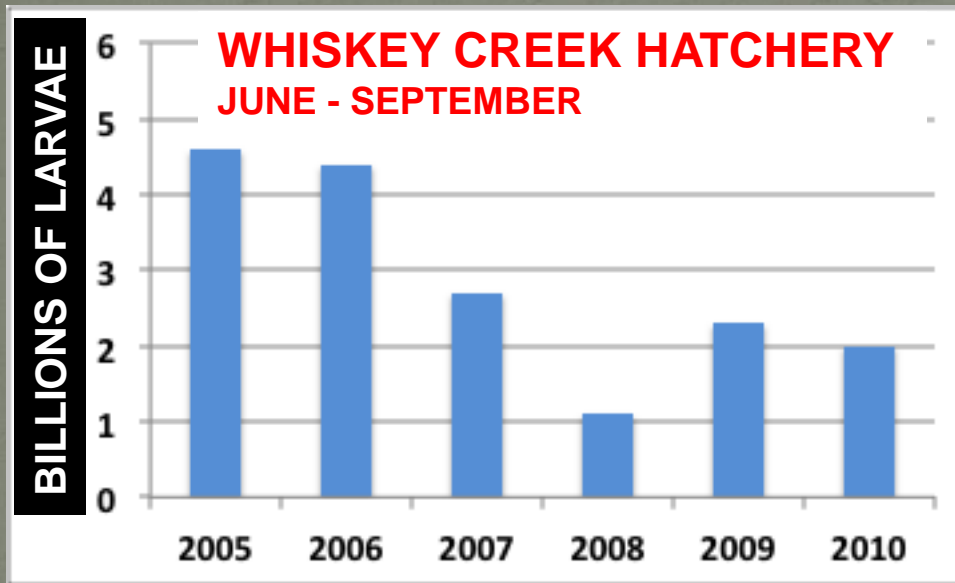
Deep cold nutrient-rich water brought to the surface with north winds



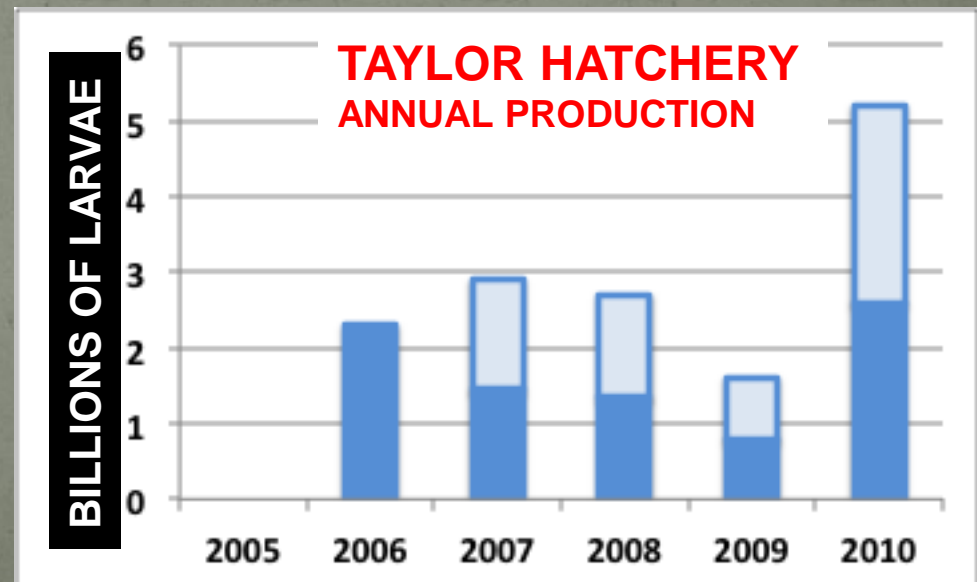
Upwelled deep water is acidic and can be corrosive for aragonite vertical section off St. George, CA. summer 2007



Impacts on larval production from two west coast commercial hatcheries



Kurihara et al 2007



Panic/Adaptation

- Taylor Shellfish – ramped up research and monitoring at Dabob Bay Hatchery
- Expanded larvae production capacity at Kona, Hawaii hatchery to offset Dabob production set backs.



Continuous Water Chemistry Monitoring



YSI 6600 (2)

Water conditions in Dabob Bay

pH, Temperature, Salinity, Oxygen, ORP, Depth
(Tide), Chlorophyll, Turbidity



YSI 5200 (3)

Water conditions entering and within the hatchery

pH, Temperature, Salinity, Oxygen, ORP



YSI Professional Plus (1)

Water conditions at any point throughout the hatchery

pH, Temperature, Salinity, Oxygen, ORP



Carbon dioxide levels in water entering the hatchery, point samples throughout the hatchery

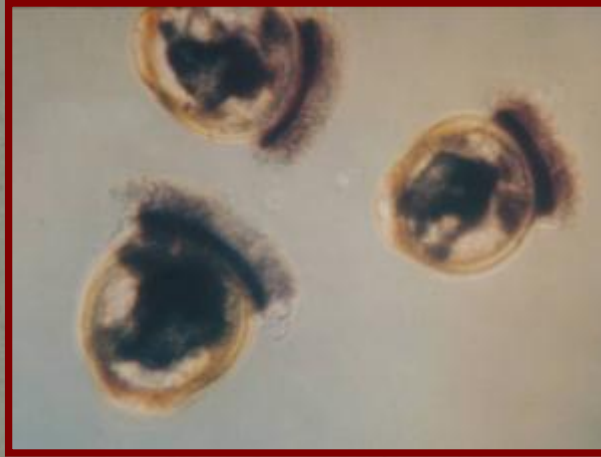
pCO₂

Discrete Sampling

- Weekly AM/PM samples sent to OSU (*Burke Hales lab*)
 - Carbonate chemistry (DIC, alkalinity, pCO₂, Ω_A , Ω_C ...)
 - Nutrients
 - Bacteriology (*Aquatechnics, R. Elston*)

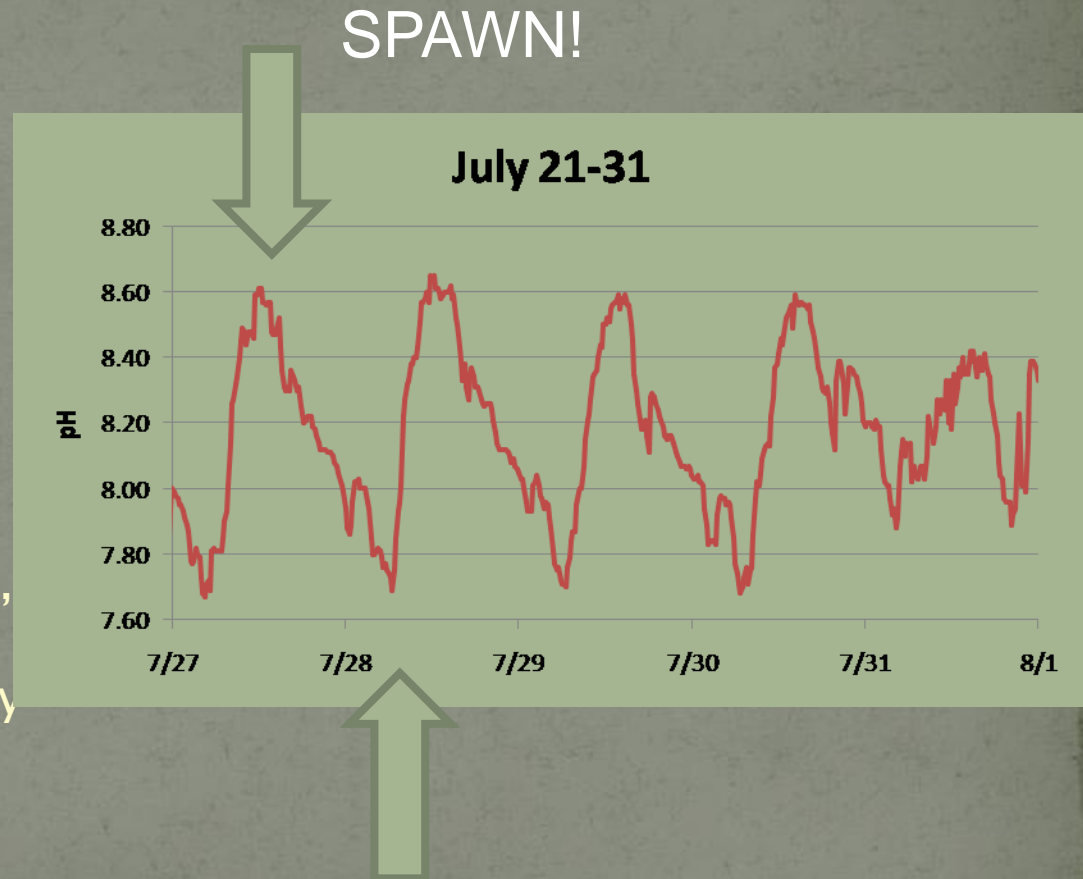
Early life stages most vulnerable

Amorphous calcium carbonate > Aragonite > Calcite

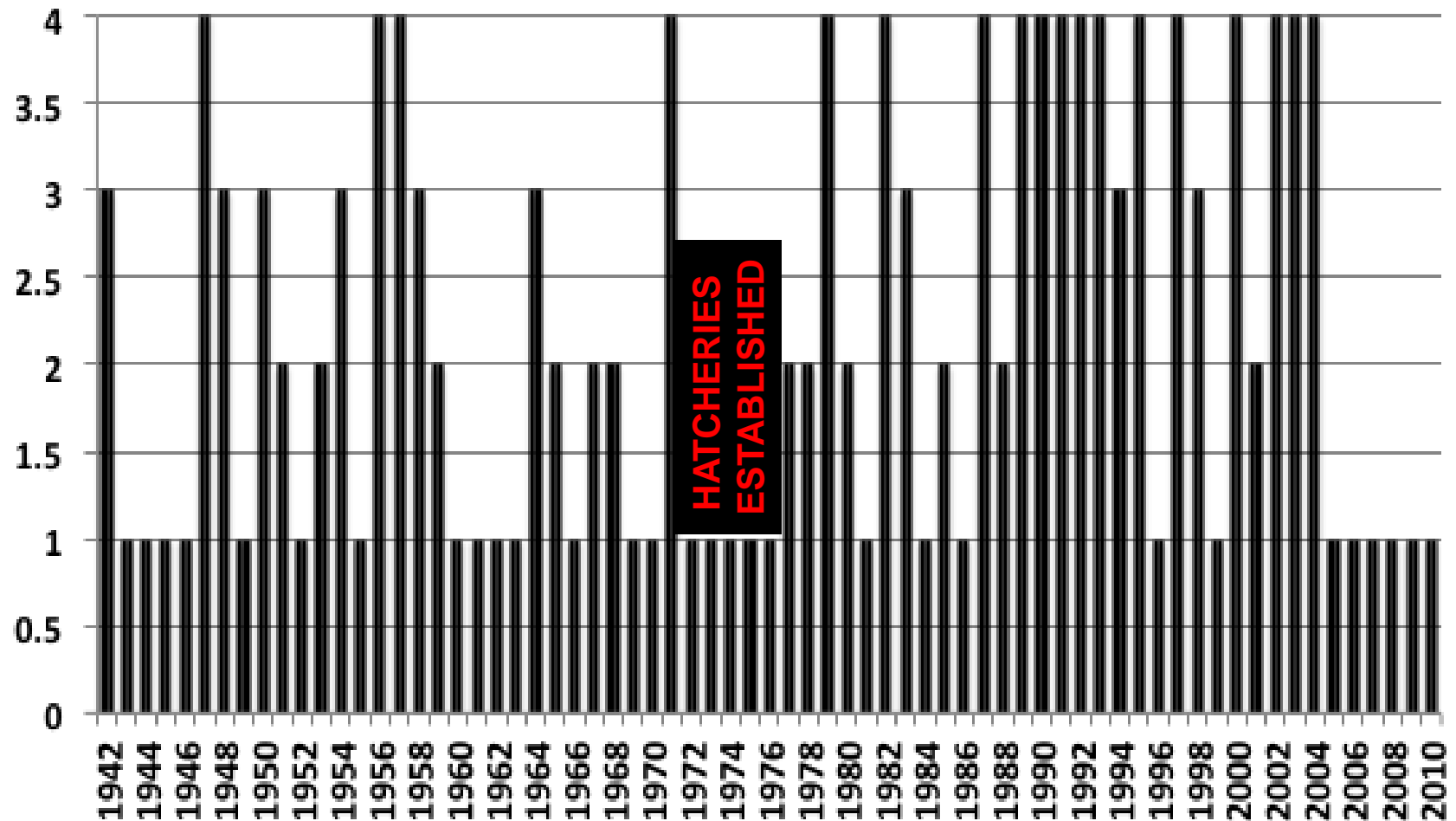


Managing around the problem

- Put small larvae into tanks filled in the afternoon or overnight
 - Works if the sun is out
- 24 hour notice– Upwelling takes a day or two to start up, so when winds from the North, fill tanks late in the day and spawn like crazy



No natural set of Pacific oysters in Willapa Bay, WA for past 6 years



Some of what we don't know

- What characteristics of upwelled water are harmful?
e.g. pH, PCO₂, DIC, DOM, reduced compounds or a combination of these factors
- How does upwelling affect *vibrio tubiashii*?
- How can hatcheries best address the long-term problems
- Adaptive measures are helping for now. Will they be enough given the projected changes in OA



Is the Pacific oyster the canary in the mineshaft?

“Miners would try to alert themselves to dangerous levels of carbon monoxide or methane gas in a mine shaft by bringing a caged canary with them as they worked. The canary would inevitably die before CO₂ reached levels toxic to people.”



Source: Wikipedia

Serinus canaria domestica

Is the Pacific oyster the canary in the mineshaft?

Of the \$4 billion in ex-vessel revenue that US commercial fishing generated in 2007, three-quarters came from animals that need calcium carbonate or fish that prey directly on “calcifiers.”



Serinus canaria domestica

What can we do?

- Embrace proven and often profitable strategies to increase energy efficiency
- Manage fossil-fuel emissions
- Limit nutrient runoff
- Reduce harm to seafood supplies through scientific monitoring and research

Questions?

